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EXECUTIVE SUMMARY

This report covers the results from a series of laboratory tests conducted on samples of SUNCOR coke, thermally hydrocracked pitch, and Syncrude coke. The samples were supplied by, and the tests were conducted under contract to, the Energy Research Laboratories of the Department of Energy, Mines and Resources in Ontario, Canada. The purpose of the tests was to make a preliminary determination regarding the suitability of these materials as feedstocks for the Texaco Gasification Process. The Texaco Gasification Process is the leading technology commercially available for use on solid carbonaceous feedstocks.

The SUNCOR coke and Syncrude coke samples appear to be good candidate feedstocks for the Texaco Gasification Process. Both samples slurry well, have high heating values, and would be expected to produce a high product gas yield.

Because of the observed slurrying characteristics, further evaluation appears to be required on the thermally hydrocracked pitch before commercial grinding/slurry preparation techniques could be considered sufficient. With the major exception of its slurrying characteristics, the thermally hydrocracked pitch would also appear to be a good candidate feedstock for the Texaco Gasification Process.

SYNTHESE ET CONCLUSIONS

Ce rapport couvre les résultats d'une série d'expériences conduite sur des échantillons de coke de SUNCOR, de résidu hydrocraqués thermiquement et de coke SYNCRUDE. Ces échantillons ont étés fournis par, et les expériences ont étés conduites sous contrat avec les Laboratoires de Recherches sur les Sources d'Energie (Energy Research Laboratories) du Département d'Energie, Mines et Resources Naturelles (Department of Energy, Mines and Resources) de l'Ontario au Canada. Le but de ces enquêtes est de faire une vérification préliminaire de ces matériaux vis-à-vis de leur emploi en tant que matière première pour le Procédé de Gazéification de Texaco (Texaco Gasification Process - TGP). Ce procédé est le mieux établi parmis les nouvelles technologies, offertes sur échelle commerciale, employant comme matières premières des combustibles fossils y compris leurs dérivés résiduels riches en carbone.

Les échantillons de coke de SUNCOR et de SYNCRUDE semblent être de bons candidats en tant que matières premières pour le Procédé de Gazéification de Texaco. Les deux échantillons forment des suspensions (dans l'eau) à haute concentration, ils ont une valeur calorifique élevée et auront probablement un excellent rendement au point de vue production de gaz de synthèse.

Des expériences supplémentaires sont recommandées afin de mieux déterminer la méthode optimale pour traiter le dernier échantillon, celui de résidu hydrocraqué. Certaines charactéristiques de la suspension formées avec le résidu doivent être étudiées plus profondément avant de pouvoir recommander les méthodes nécessaires pour préparer une suspension sur échelle commerciale. A part cela, le résidu semble aussi être un bon candidat en tant que matière première pour le Procédé de Gazéification de Texaco.

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I. INTRODUCTION

This report covers the results from a series of laboratory tests conducted on samples of SUNCOR coke, thermally hydrocracked pitch, and Syncrude coke. The samples were supplied by, and the tests were conducted under contract to, the Energy Research Laboratories of the Department of Energy, Mines and Resources in Ontario, Canada. The purpose of the tests was to make a preliminary determination regarding the suitability of these materials as feedstocks for the Texaco Gasification Process. The tests were conducted by Texaco at its pilot plant facilities located in Montebello, California. One of the major purposes of these facilities is to provide extensive evaluation, from selected laboratory testing to sustained gasification test runs on any of three 15 ton-per-day gasifiers, of candidate feedstocks for the Texaco Gasification Process. The Texaco Gasification Process is the leading technology commercially available for use on solid carbonaceous feedstocks.

II. TECHNICAL DISCUSSION

Each sample underwent the battery of testing typically referred to be Texaco as a "Type I" analysis. Included were the following determinations for each of the three candidate feedstocks:

1. As received moisture content
2. Hardgrove Grindability Index
3. Proximate analysis
4. Ultimate analysis
5. Gross heating value
6. Ash fusion temperatures
7. Ash analysis
8. Slurry viscosity data
9. Initial slurry pH

The Texaco Gasification Process utilizes a slurry feed (i.e., a water/solid hydrocarbon mixture) to introduce the feedstock into the gasifier. Accordingly, the ability to produce a relatively high slurry concentration is an important economic consideration. Commercial plants utilizing the Texaco Gasification Process typically operate with slurry concentrations ranging from the low 60's to the high 60's, on a weight per cent solids basis. The equilibrium moisture content of the feedstock is a limiting factor in the ability to achieve high slurry concentrations. The "as received moisture" for a sample of this type is considered an approximation for the equilibrium moisture of the feedstock. The results are shown in Table 1.

The Hardgrove Grindability Index provides an indication of the performance to be expected with the conventional wet grinding system utilized in the Texaco Gasification Process. It is also

used as a design specification for selecting the actual grinding equipment. The results are shown in Table 2.

The amount of volatility in the feedstock provides an indication of feedstock reactivity. This is obtained from the proximate analysis. The feedstock composition and gross heating value are used in determining the efficiency of gasification performance and product gas yield. These are obtained from the ultimate analysis and the gross heating value tests. The results are shown in Tables 3 - 5 respectively.

The Texaco Gasification Process operates in the slagging mode, which means that the gasifier combustion chamber operates at high enough temperature to keep the feedstock ash in a molten form, rather than in a solid or "fly ash" form. Typical commercial plant economics call for operating the gasifier at as low a temperature as practical, which results in a temperature limitation sufficiently high enough to keep the ash molten. A good approximation of this temperature limitation can be obtained from the fluid temperature of the ash, as measured in a reducing environment. The results are shown in Table 6.

The ash composition is determined for several reasons. Certain constituents tend to be especially erosive/corrosive to the refractory lining inside the gasifier, and this must be taken into account when selecting the refractory material. Certain ash constituents are water soluble, and this must be taken into account when designing the gasification water system. Finally, certain ash constituents may have relatively high ash fluid temperatures, thereby becoming an uneconomical limiting factor for gasifier operating temperature. In the Texaco Gasification Process, this effect can sometimes be modified by adding one of several fluxing agents to reduce the ash fluid temperature. The results are shown in Table 7.

Another limitation frequently encountered in achieving high slurry concentrations is the mechanical ability of the slurry feed system pumps to handle high viscosity fluid. Slurry additives can be a cost-effective way to reduce slurry viscosity, thereby allowing the use of higher slurry concentrations. A commercially available ammonium lignin sulfonate was used to provide a comparison. To a lesser extent, the slurry pH can also be an important factor in the benefits achieved by the use of slurry additives. The results of the latter are shown in Table 8.

III. CONCLUSIONS AND RECOMMENDATIONS

The SUNCOR coke and Syncrude coke samples appear to be good candidate feedstocks for the Texaco Gasification Process. Both samples slurry well in that high slurry concentrations can be achieved, even without the use of viscosity-reducing additives. Accordingly, both slurried samples have high heating values, and

would be expected to produce a high product gas yield. Neither feedstock would appear to require an ash fusion temperature moderator. It should be noted that depending upon the variability expected in these feedstocks, the measured ash fluid temperature is approaching the point at which a fluxing agent to lower the ash fusion temperatures should be considered. Noting that the next step in the normal progression toward designing a commercial plant would be pilot plant gasification testing, it is recommended that additional sampling for variability and ash slag testing be conducted prior to undertaking such pilot plant gasification testing. Regarding the Syncrude coke, it should also be noted that because of the large amount of fine material, only 40% of the solids in the slurry had to be ground. The remaining 60% of the solids was mixed directly into the slurry without grinding. If this characteristic is representative of commercial production, significant savings in the design of the grinding system of a commercial plant would be achieved.

With the major exception of its slurrying characteristics, the thermally hydrocracked pitch would also appear to be a good candidate feedstock for the Texaco Gasification Process. However, because of the significant quantity of fines in the delivered sample, a concentrated slurry was not achieved. Accordingly, given that this is a representative characteristic of commercial production, extensive study and evaluation on the grinding/slurry preparation system, including the use of an additive, would be required before normal grinding/slurry preparation techniques currently employed could be considered sufficient.

TABLE 1

MOISTURE WT.% AS RECEIVED

MRL Number Type of Sample	85-MRL-377 SUNCOR COKE	85-MRL-378 PITCH	85-MRL-379 SYNCRUDE COKE
	0.47	trace	4.17

TABLE 2

HARDGROVE GRINDABILITY INDEX

MRL Number Type of Sample	85-MRL-377 SUNCOR COKE	85-MRL-378 PITCH	85-MRL-379 SYNCRUDE COKE
	50.	(1)	(1)

(1) not determined because of quantity of fines in sample.

TABLE 3

PROXIMATE ANALYSIS, WT.%

MRL Number Type of Sample	85-MRL-377 SUNCOR COKE	85-MRL-378 PITCH	85-MRL-379 SYNCRUDE COKE
Ash	3.99	(2)	7.04
Volatile Matter	12.48	(2)	14.48
Fixed Carbon	83.53	(2)	78.48

(2) Not applicable.

TABLE 4

ULTIMATE ANALYSIS, WT.%

MRL Number Type of Sample	85-MRL-377 SUNCOR COKE	85-MRL-378 PITCH	85-MRL-379 SYNCRUDE COKE
Carbon	84.02	80.67	80.65
Hydrogen	3.67	6.74	1.64
Nitrogen	1.38	1.28	1.51
Sulfur	5.73	5.53	6.85
Chloride (Maximum)	0.003	0.003	0.003
Ash	3.99	5.35	7.04
Oxygen By Diff	1.21	0.43	2.31

TABLE 5

GROSS HEATING VALUE, BTU/LB.

MRL Number Type of Sample	85-MRL-377 SUNCOR COKE	85-MRL-378 PITCH	85-MRL-379 SYNCRUDE COKE
Moisture Free	14,512.	15,120.	12,943.
Moisture Ash Free	15,115.	16,070.	13,923.

TABLE 6

ASH FUSION TEMPERATURES, EITHER °F OR DEG F
(In Reducing Atmosphere)

MRL Number Type of Sample	85-MRL-377 SUNCOR COKE	85-MRL-378 PITCH	85-MRL-379 SYNCRUDE COKE
Initial	1,965.	1,975.	1,980.
Softening	2,345.	2,405.	2,360.
Hemispherical	2,440.	2,445.	2,435.
Fluid	2,635.	2,660.	2,585.

TABLE 7

ASH ANALYSIS

MRL Number Type of Sample	85-MRL-377 SUNCOR COKE	85-MRL-378 PITCH	85-MRL-379 SYNCRUDE COKE
SiO_2	37.00	42.79	36.47
Al_2O_3	21.31	27.90	25.23
TiO_2	3.34	3.43	3.08
Fe_2O_3	11.47	9.89	8.73
CaO	4.91	4.18	6.16
NaO_2	0.68	0.50	0.96
K_2O	0.91	1.13	1.03
MgO	2.91	2.79	3.06
P_2O_5	N/A	N/A	N/A
SO_3	5.39	3.74	5.93
MnO_2	N/A	N/A	N/A
NiO_2	1.28	0.95	1.08
Total	94.55	101.97	96.80

TABLE 8

INITIAL SLURRY pH

MRL Number Type of Sample	85-MRL-377 SUNCOR COKE	85-MRL-378 PITCH	85-MRL-379 SYNCRUDE COKE
	7.3	7.8	5.6

For future reference, the SUNCOR coke has been labeled as sample 85-MRL-377, the thermally hydrocracked pitch as 85-MRL-378, and the Syncrude coke as 85-MRL-379.